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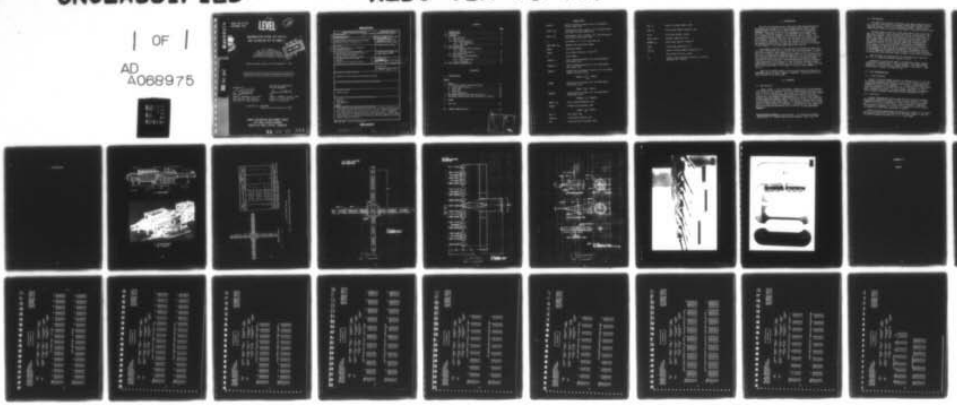

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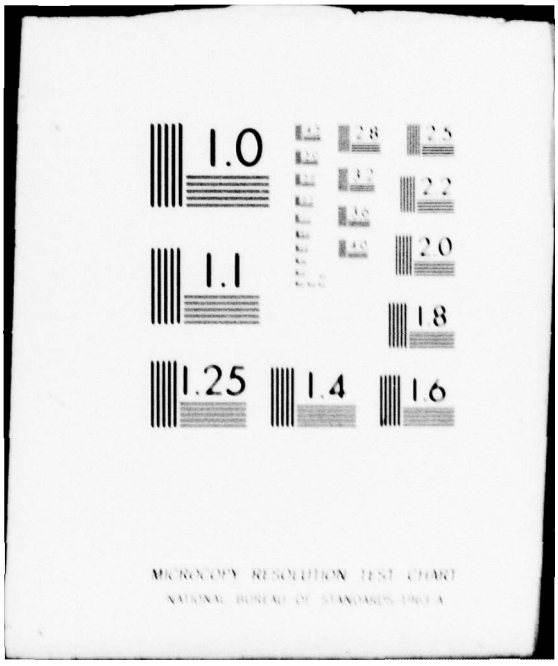
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AEDC-TSR-78-V49
DECEMBER 1978

LEVEL II

AEROPROPULSION SYSTEMS TEST FACILITY RAKE CALIBRATION TEST IN TUNNEL A

W. A. Crosby
ARO, Inc., AEDC Division
A Sverdrup Corporation Company
von Kármán Gas Dynamics Facility
Arnold Air Force Station, Tennessee

Period Covered: October 24-26 and November 9, 1978

Approved for public release; distribution unlimited.

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FOR THE COMMANDER

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Prepared for: AEDC/XRFD
Arnold Air Force Station, TN 37389

ARNOLD ENGINEERING DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
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pressure
Mach number
flow angularity
probe
Rake

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A pressure test was conducted in the VKF Tunnel A to obtain calibration data on the APTU Free-Jet Nozzle Calibration Rake. The test covered the supersonic Mach number range of 1.76, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0, nominally, at a free-stream unit Reynolds number of 5.0 million per foot. The angle-of-attack range was -6 to +6 deg with typical roll angles of 0 and -90 deg. Model flow-field schlieren photographs were obtained at all Mach numbers at 0 deg and positive angles-of-attack.

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CONTENTS

APPENDIXES

NOMENCLATURE

ALPHA, α	Angle of attack, positive pitch up independent of roll angle, deg
DPP-N, Δp_p	Differential static pressure, 40° (included-angle) cone probe in pitch plane, psid
DPY-N, Δp_y	Differential static pressure, 40° (included-angle) cone probe in yaw plane, psid
m	Tap number, m = 1,2,3,4 (see Fig. 2d)
MACH (INF), M_∞	Nominal free stream Mach number
MNS-N	Local Mach number
MUINF	Free stream viscosity, lb_f-sec/ft^2
N	Probe number
PCRS-N, p	Static pressure-measured, 20° (included-angle) cone probe, psia
PCRSm-N, p	Static pressure-measured, 40° (included-angle) cone probe, psia
PCRSA-N	Average static pressure of probe N, 40° (included-angle) cone probe, psia $$\text{PCRSA-N} = \frac{1}{4}\sum_{m=1}^{4} \text{PCRSm-N}$$
PCRSAV	Average static pressure, 20° (included-angle) cone probe, psia $$\text{PCRSAV} = \frac{1}{20}\ \Sigma\ \text{PCRS-N}$$
PCRSmAV	Average static pressure, 40° (included-angle) cone probe, psia $$\text{PCRSmAV} = \frac{1}{9}\ \Sigma\ \text{PCRSm-N}$$
PCRT-N, p_o'	Pitot pressure-measured, psia
PCRTAV	Average pitot pressure, psia $$\text{PCRTAV} = \frac{1}{29}\ \Sigma\ \text{PCRT-N}$$
PHI, ϕ	Roll angle, deg
PINF, p_∞	Free-stream pressure, psia
POP	Calculated pitot pressure, psia

PTO, p_o	Tunnel stilling chamber, psia
QINF, q_∞	Free-stream dynamic pressure, psia
R(SI)	Scan item reading, counts
RE/FT, Re/ft	Reynolds number per foot
RHOINF, ρ_∞	Free-stream density, slugs/ft^3
TINF	Free-stream temperature, °R
TTO, T_o	Tunnel stilling chamber temperature, °R
U	Free-stream velocity, ft/sec
XT	Tunnel position measured from pin A, positive upstream, XT = 6.60 in.

1.0 INTRODUCTION

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 65807F, Control Number 9R04-01-9, at the request of AEDC/XRFD, Arnold Air Force Station, Tennessee for the Engine Test Facility's (ETF) APTU projects. The AEDC/XRFD project monitor was W. L. Simmons and the ETF/APTU project monitor was W. W. Muse. The results were obtained by ARO, Inc., AEDC Division (a Sverdrup Corporation Company), operating contractor for the AEDC, AFSC, Arnold Air Force Station, Tennessee. The test was conducted in the von Karman Gas Dynamics Facility (VKF), during the period of October 24 to October 26 and November 9, 1978, under ARO Project No. V41A-53.

The primary objective of this test was to calibrate the APTU free-jet nozzle calibration rake in a known flow-field environment. Pressure data were obtained at Mach numbers 1.76, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0 at a nominal free-stream Reynolds number of 5.0 million per foot. Data were also obtained at Reynolds numbers of 1.0- and 7.0-million per foot at Mach number 3.0 to check for the effects of Reynolds number variation on the calibration. The rake was pitched from -6 to 6 deg in 2-deg increments at roll angles of 0 and -90 deg at each Mach number. Additionally, data were obtained at zero pitch with roll angle = 180 deg and at each pitch angle at roll angle = 45 deg for Mach numbers 3.5 and 4.5.

Inquiries to obtain copies of the test data should be directed to AEDC/XRFD, Arnold Air Force Station, Tennessee. A microfilm record has been retained in the VKF at AEDC.

2.0 APPARATUS

2.1 TEST FACILITY

Tunnel A (Fig. 1) is a continuous, closed-circuit, variable density wind tunnel with an automatically driven flexible-plate-type nozzle and a 40- by 40-in. test section. The tunnel can be operated at Mach numbers from 1.5 to 6 at maximum stagnation pressures from 29 to 200 psia, respectively, and stagnation temperatures up to 750°R at Mach number 6. Minimum operating pressures range from about one-tenth to one-twentieth of the maximum at each Mach number. The tunnel is equipped with a model injection system which allows removal of the model from the test section while the tunnel remains in operation. A description of the tunnel and airflow calibration information may be found in the Test Facilities Handbook*.

*Test Facilities Handbook (Tenth Edition). "von Karman Gas Dynamics Facility Vol. 3." Arnold Engineering Development center, May 1974.

2.2 TEST ARTICLE

The APTU free-jet nozzle calibration rake (ARO drawing RR-620150) is a cruciform arm assembly containing 20 Mach number probes, 9 flow angularity probes, and 12 total temperature probes. Identification numbering and radial location for each probe is described in Figs. 2 and 3.

The Mach number probes are 10-deg (half-angle) cone probes (See Fig. 2d) containing a pitot pressure tap and four surface-static taps manifolded together. The flow angularity probes are 20-deg (half-angle) cone probes (see Fig. 2d) containing a pitot pressure tap and four surface-static pressure taps with individual pressure tubing. The pressure tubing for both the Mach number and flow angularity probes are 0.064 in. -O.D. stainless steel tubing, approximately 12 ft in length. An additional six ft of 0.093-in.-O.D. tubing was silver soldered to the rake tubing, extending the length ($\doteq$ 18 ft) to accommodate the VKF pressure transducers. Measurements from the 12 total temperature probes were not included in this study and hence no description other than that shown in Figs. 2d and 3 will be provided.

The rake body is constructed of 347 stainless steel; each arm is 1.5 in. in width and extends radially 14.72 in.

Hardware for mounting the rake to the VKF model support system consisted of an adapter and a coupling assembly. The model support system used in this study was a simple straight sting support. Rake installation in Tunnel A is shown in Fig. 4.

2.3 TEST INSTRUMENTATION

2.2.1 Test Conditions

Tunnel A stilling chamber pressure is measured with a 15, 60, 150, or 300 psia transducer referenced to a near vacuum. Based on periodic comparisons with secondary standards, the accuracy (a bandwidth which includes 95 percent of the residuals, i.e. 2σ deviation) of these transducers is estimated to be within ±0.2 percent of pressure or ±0.015 psia, whichever is greater. Stilling chamber temperature is measured with a copper-constantan thermocouple with an uncertainty of ±3°F.

2.3.2 Test Data

Pressure measurements from the rake were made using the standard VKF pressure transducer package in Tunnel A which consists of 15-psid transducers which are referenced to a near vacuum and are calibrated at 0.5, 1, 3, 6, 9, 12, and 15 psid. Based on periodic comparisons with secondary standards, the accuracy is estimated to be ±0.2 percent of pressure or ±0.003 psia, whichever is greater.

Model flow-field shadowgraph photographs were obtained of the rake's typical pitch orientation in Tunnel A for each Mach number at zero and all positive angles of attack (i.e. 0, 2, 4 and 6 deg).

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS AND PROCEDURES

3.1.1 General

A summary of the nominal test conditions at each Mach number is given below.

M_∞	p_o, psia	T_o, °R	q_∞, psia	p_∞, psia	Re /ft x 10^{-6}
1.76	17.0	560	6.82	3.145	5.0
2.00	20.5	↓	7.34	2.620	↓
2.50	26.1	↓	6.68	1.528	↓
3.01	33.9	↓	5.77	0.909	↓
↓	6.8	↓	1.16	0.182	1.0
↓	46.8	↓	7.96	1.255	7.0
3.51	46.5	580	5.18	0.601	5.0
4.02	52.7	↓	3.82	0.338	↓
4.52	81.0	↓	3.94	0.275	↓
5.05	110.0	640	3.50	0.196	↓

At some test conditions, particularly at subatmospheric stagnation pressures, the air humidity level affects the test section Mach number. The Tunnel A sidewall Mach number probe is used periodically when testing at these conditions to monitor deviations from the standard calibrated Mach numbers. When a deviation is measured, the free-stream conditions are corrected and the actual Mach number is printed on the data tabulations.

A test summary showing all configurations tested and the variables for each is presented in Table 1.

In the VKF continuous flow wind tunnels (A, B, C), the test article is mounted on a sting support mechanism in an installation tank directly underneath the tunnel test section. The tank is separated from the tunnel by a pair of fairing doors and a safety door. When closed, the fairing doors, except for a slot for the pitch sector, cover the opening to the tank and the safety door seals the tunnel from the tank area. After the test article is prepared for a data run, the personnel access door to the installation tank is closed, the tank is vented to the tunnel flow, the safety and fairing doors are opened, the test article is injected into the airstream, and the fairing doors are closed. After the data are obtained, the test article is retracted into the tank and the sequence is reversed with the tank being vented to atmosphere to allow access to the test article in preparation for the next run. The sequence is repeated for each configuration change.

Rake attitude positioning and data recording were accomplished with the point-pause mode of operation, using the VKF Model Attitude Control System (MACS). Rake pitch and roll requirements were entered into the controlling computer prior to the test. Rake positioning operations were performed automatically during the test by selecting the list of desired model attitudes and initiating the system.

3.1.2 Data Acquisition

Pitot and cone static pressure readings were recorded directly from the VKF pressure transducer package described in Section 2.3.2. A pressure monitoring system (PMS) is available in the circuit for observing the raw counts and Δcounts of the 48 transducers per valve position, where Δcounts = $R(SI)_i - R(SI)_{i-1}$. When Δcounts are near zero, the pressures have stabilized in the sensing lines and may be recorded. For this test, stabilization times were on the order of 10 seconds. A data group was ended after the completion of the angle-of-attack schedule.

3.2 DATA REDUCTION

Data were obtained utilizing the tunnel data acquisition system as described in Section 3.1.2. Rake pressures were reduced using an existing VKF pressure program. Tunnel conditions were calculated from the first loop values and the probe pressures were typically normalized using measured pitot pressure for each cone probe. For example, the differential static pressure computations in the pitch and yaw planes of the 40° (included-angle) cone probes were normalized by the probe pitot pressure. Non-standard reduction equations used in some calculations are contained in Section 4.0.

3.3 UNCERTAINTY OF MEASUREMENTS

3.3.1 General

The accuracy of the basic measurements (p_o and T_o) was discussed in Section 2.3. Based on repeat calibrations, these errors were found to be

$$\frac{\Delta p_o}{p_o} = 0.002 = 0.2\%, \quad \frac{\Delta T_o}{T_o} = 0.005 = 0.5\%$$

Uncertainties in the tunnel free-stream parameters and the model aerodynamic coefficients were estimated using the Taylor series method of error propagation, Eq. (1),

$$(\Delta F)^2 = \left(\frac{\partial F}{\partial X_1}\Delta X_1\right)^2 + \left(\frac{\partial F}{\partial X_2}\Delta X_2\right)^2 + \left(\frac{\partial F}{\partial X_3}\Delta X_3\right)^2 \cdots + \left(\frac{\partial F}{\partial X_n}\Delta X_n\right)^2 \qquad (1)$$

where ΔF is the absolute uncertainty in the dependent parameter $F = f(X_1, X_2, X_3 \ldots X_n)$ and X_n are the independent parameters (or basic measurements). ΔX_n are the uncertainties (errors) in the independent measurements (or variables).

3.3.2 Test Conditions

The following table lists the test conditions.

M_∞	Re/ft x 10^{-6}	p_o (psia)	T_o (°R)
1.76	5.0	17.0	560
2.0	↓	20.5	↓
2.5	↓	26.1	↓
3.0	↓	33.9	↓
3.0	1.0	6.8	↓
3.0	7.0	46.8	↓
3.5	5.0	46.5	580
4.0	↓	52.7	↓
4.5	↓	81.7	590
5.0	↓	110.0	640

The accuracy (based on 2σ deviation) of the basic tunnel parameters, p_o and T_o, (see Section 2.3) and the 2σ deviation in Mach number determined from test section flow calibrations were used to estimate uncertainties in the other free-stream properties using Eq. (1). The computed uncertainties in the tunnel free-stream conditions are summarized in the following table.

	Uncertainty, (±) percent of actual value			
M_∞	M_∞	p_∞	q_∞	Re/ft
1.76	0.9	2.3	0.6	0.9
2.0	0.8	2.5	0.9	1.0
2.5	0.5	1.9	0.9	1.0
3.0	0.6	2.6	1.4	1.2
3.5	0.3	1.7	1.0	1.0
4.0	0.4	2.4	1.5	1.2
4.5	0.5	2.7	1.8	1.3
5.0	0.5	3.0	2.0	1.4

3.3.3 Test Data

The uncertainty in the primary rake probe pressure parameters are presented in the following tables. These were established at the described free-stream operating conditions using the Taylor series method of error propagation (Eq. 1) determined from the accuracy of the Tunnel A standard pressure system transducers (Section 2.3) and the uncertainties in the tunnel parameters (p_∞, q_∞) listed in Section 3.3.2.

In general, the basic Tunnel A pressure system is regularly calibrated against a secondary standard to within an uncertainty of nominally ±0.2 percent of the reading as discussed in Section 3.3.1. This results in the following uncertainty in the probe measurements.

Uncertainties Based on Probe Pressures, ± Percent

M_∞	p/p_∞	*$\Delta p/p_o'$	*Flow Angle
1.76	2.3	8.0	8.0
2.0	2.5	6.0	6.0
2.5	1.9	5.0	5.0
3.0	2.6	4.0	4.0
3.5	1.7	4.0	4.0
4.0	2.4	3.0	3.0
4.5	2.7	3.0	3.0
5.0	2.0	3.0	3.0

*Based on one degree pitch angle of the probe.

Additional uncertainty calculations provide the following list of values:

Sector Pitch Angle (from calibrations)	±0.05 deg
Pitot Probe Ratio (p_o'/p_o)	±0.3%
Rake Static Pressure Ratio (p/p_o)	±0.3%
Mach Number (Based on Pitot Probe Ratio)	±0.01

Note that the local flow angles in the test section (from tunnel calibration) are estimated to be within ±0.2 deg in the horizontal (yaw) plane and to range from ±0.2 to ±0.4 deg in the vertical (pitch) plane with flow angle increasing with distance off axis. The tunnel flow angle will have a direct effect on the probe angle at which the $\Delta p/p_o'$ of the probe equals zero, but a negligible effect on the slope of this parameter $\Delta p/p_o'$ with probe pitch or yaw angle. The slope will be primarily influenced by the uncertainty in the basic pressure measurements and the sector pitch angle uncertainty.

4.0 DATA PACKAGE PRESENTATION

Tabulated pressure data are presented in the form of direct pressure measurements, pressure ratios normalized with the corresponding probe pitot pressure and/or pressure differentials across the 20 deg (half-angle) probes. Sample tabulations of the data obtained during the test are provided in Appendix III.

The following list describes the nonstandard data reduction equations used for this test:

A. Pitot Pressures

1.* PCRT-12 = [(PCRT-14) + (PCRT-1)]/2
2.* PCRT-28 = [(PCRT-27) + (PCRT-30)]/2

B. Static Pressures (40° included-angle cone probe)

1.** PCRS2-41 ≡ 0.00. Plugged probe, not connected.

C. Differential Static Pressures

1.** Those containing PCRS2-41:
    a. PCRS2-41 = PCRS4-41
2.* If PHI = + 45.00 deg:
    a. DPP-N ≡ (PCRS1-N)-(PCRS3-N)
    b. DPY-N ≡ (PCRS4-N)-(PCRS2-N)

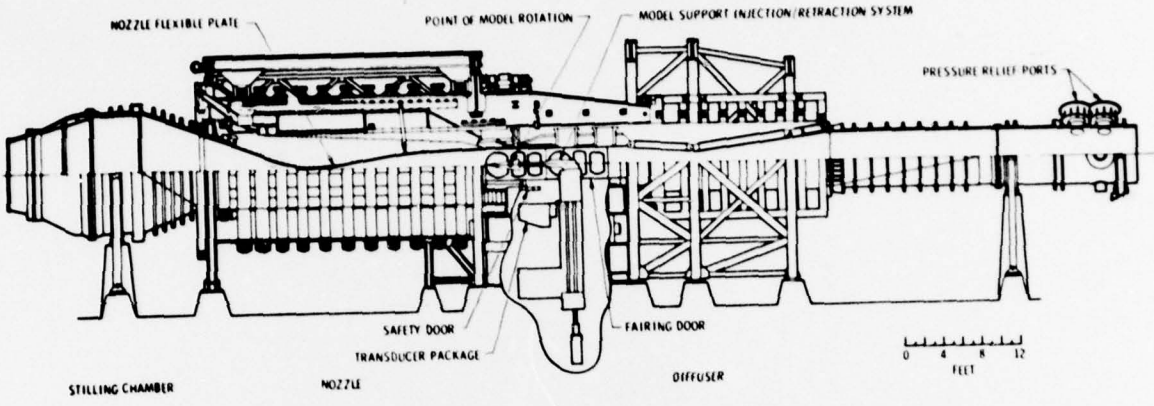
---

*Used in Groups 1-33 only.

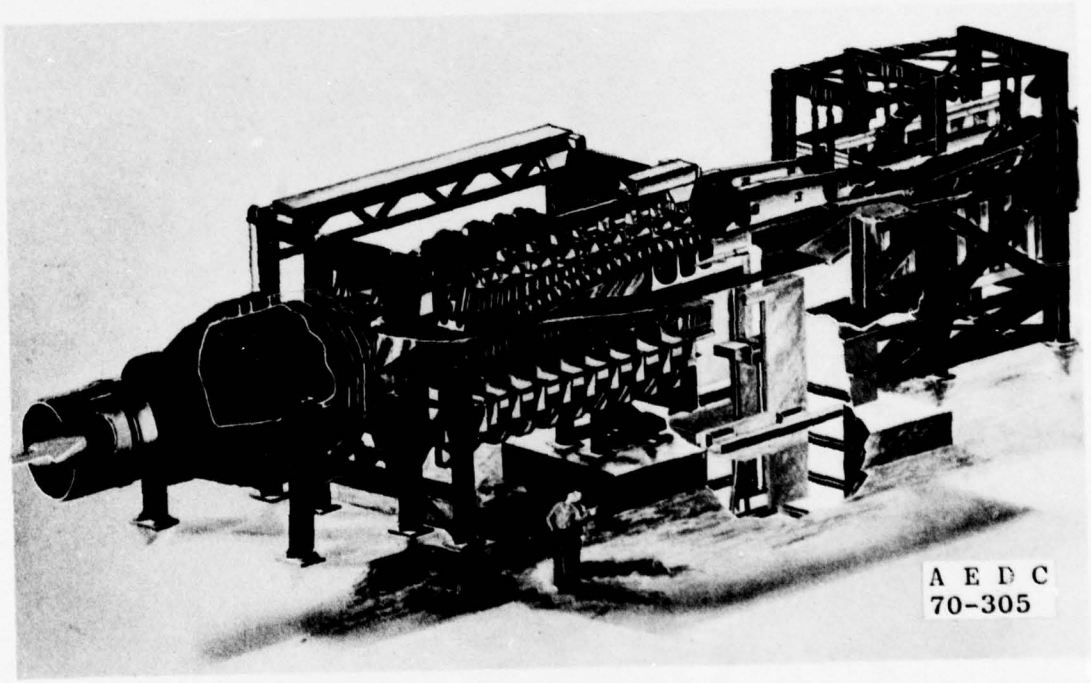
**Applicable to all Groups.

Random noise in the pressure data acquisition system generated questionable readings recorded during the first entry from the following pressure taps: pitots-015, 125, 285, 415 and cone statics-011, 101, 111, 211, 251, 311, 411. This problem was eliminated prior to the second entry and the data quality was within the predicted uncertainty. Of course, those probes identified as leaking or plugged should be approached cautiously for their use in calibrating the APTU Rake or in assessing the uncertainty in the probe calibration. Those probes are identified in the Final Data Package.

I. ILLUSTRATIONS

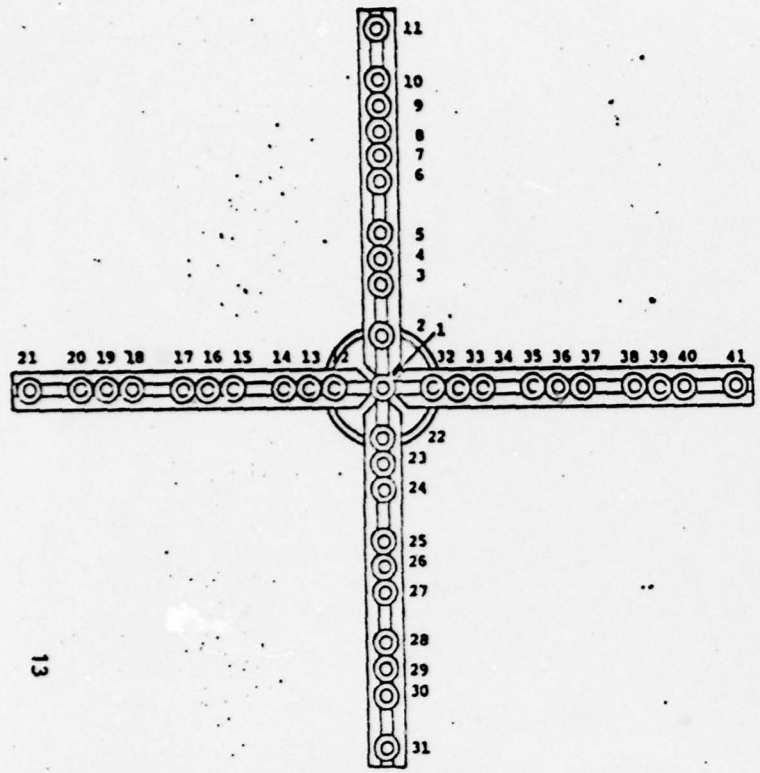


a. Tunnel assembly



b. Tunnel test section

Fig. 1 Tunnel A



Looking Downstream

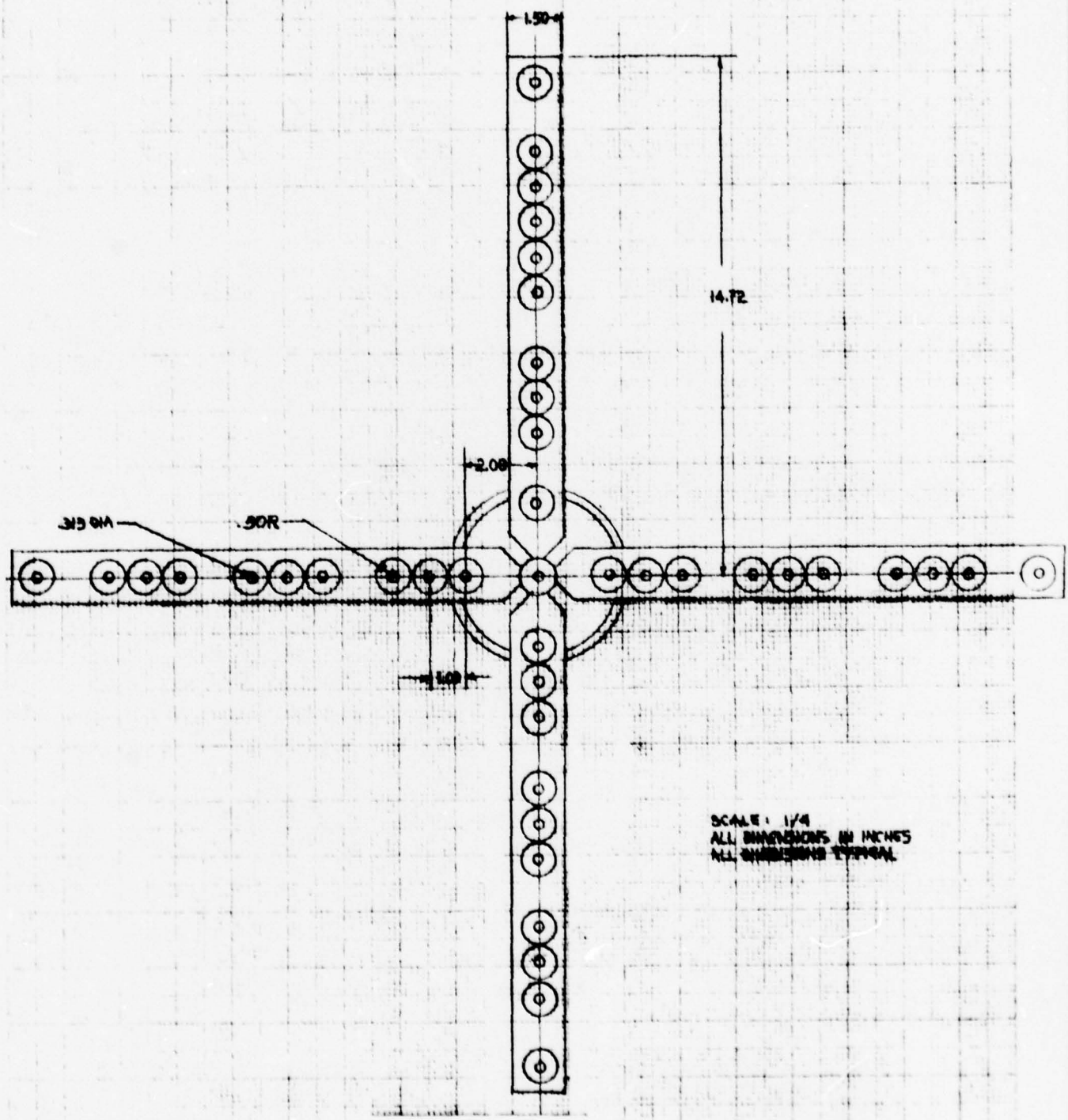
Radial Location (in. from ℄)	Probe Number	Type Probe		
		Mach Number*	Flow Angularity**	Total Temperature
0	1		X	
2	2, 12, 22, 32	X		
3	13, 23, 33			X
4	3, 14, 24, 34	X		
5	4			X
6	5, 15, 25, 35	X		
7	16, 26, 36			X
8	6, 17, 27, 37		X	
9	7			X
10	8, 18, 28, 38	X		
11	9, 19, 29, 39			X
12	10, 20, 30, 40	X		
14	11, 21, 31, 41		X	

*20 deg included angle cone probe consisting of a pitot pressure tap and 4 cone static pressure taps manifolded together

**40 deg included angle cone probe consisting of a pitot pressure tap and 4 individual cone static taps

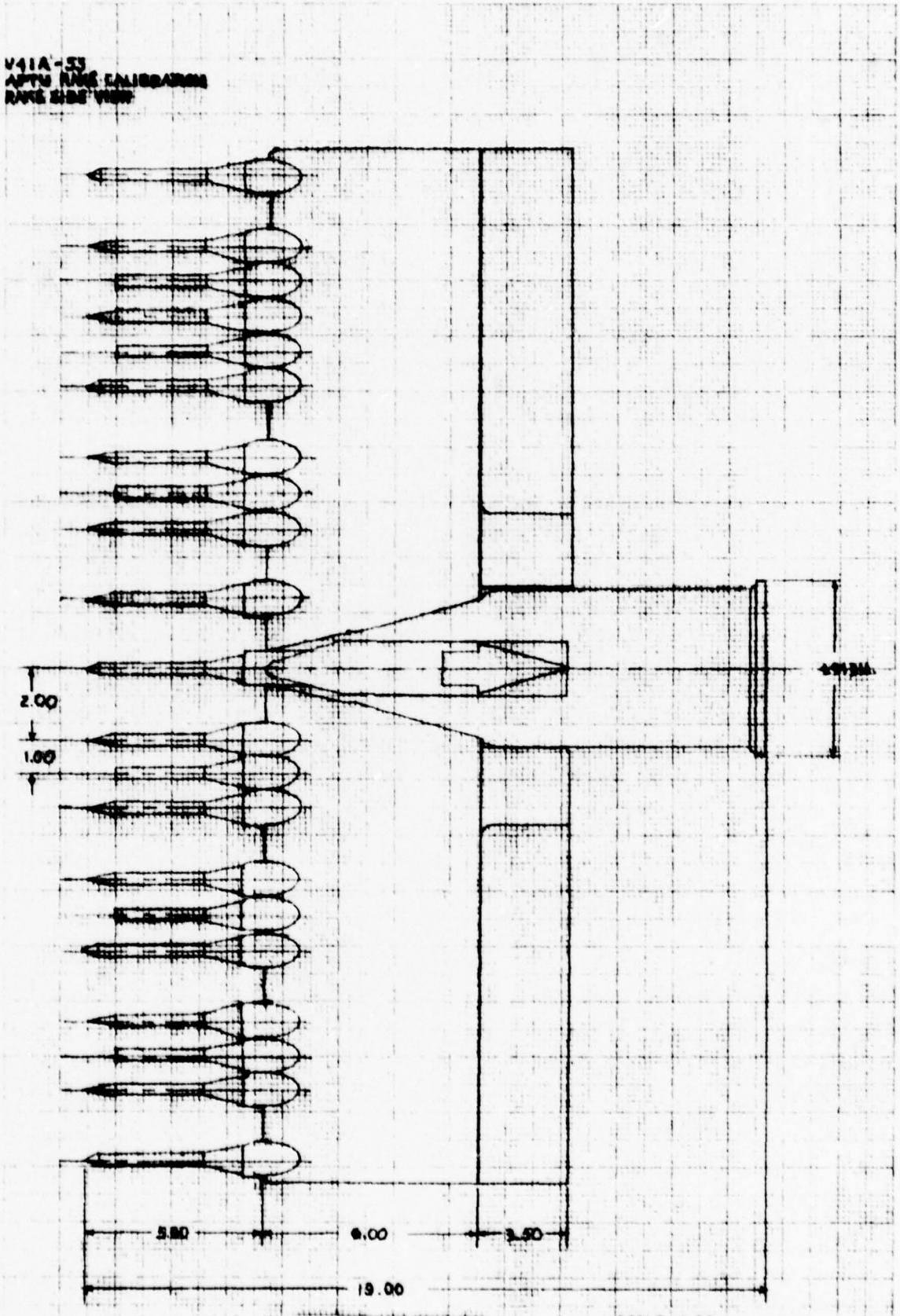
a. Probe Identification

Fig. 2 APTU Free-Jet Nozzle Calibration Rake



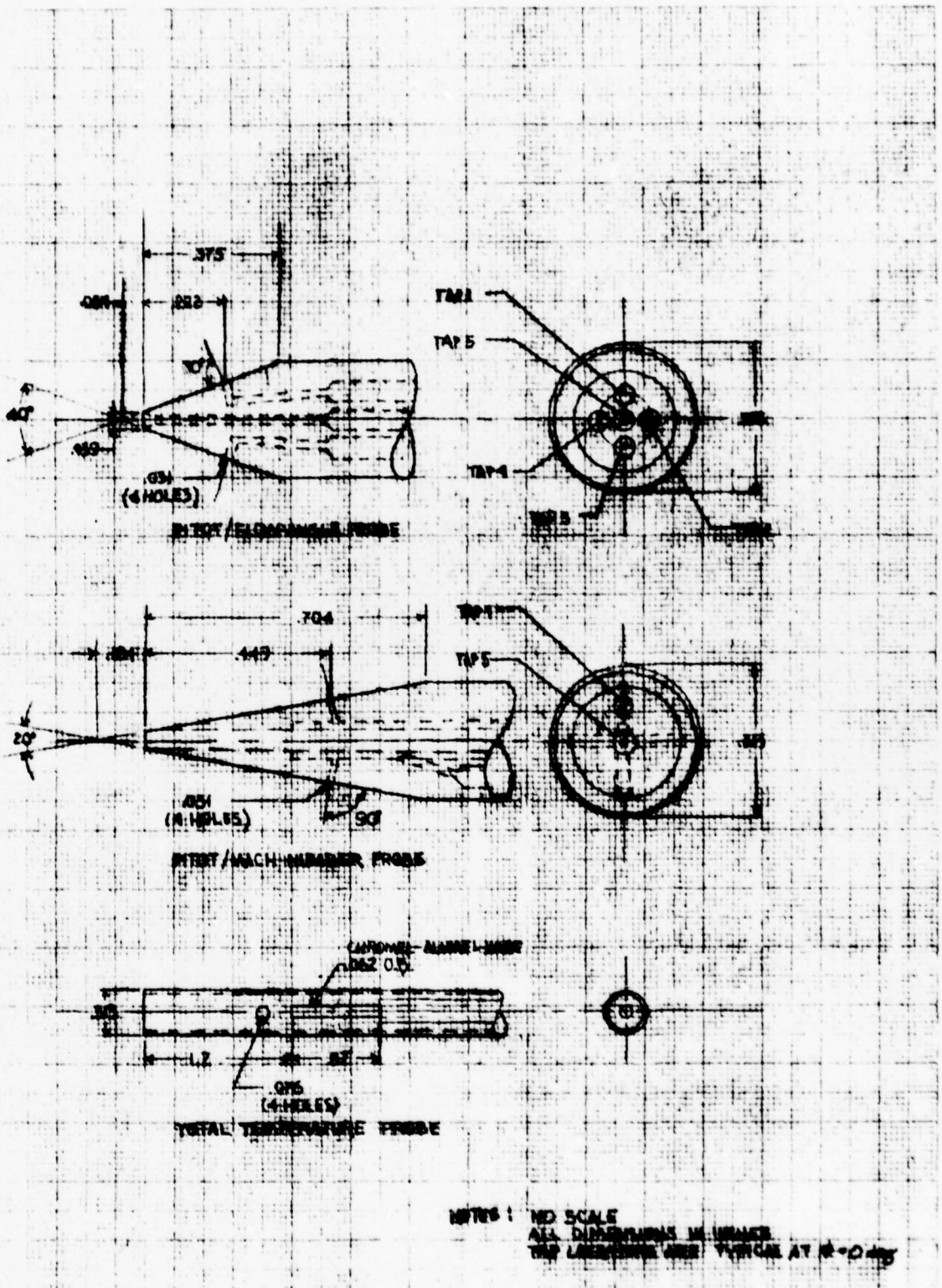
b. Front View

Fig. 2 Continued



c. Side View

Fig. 2 Continued



d. Probe Dimensions

Fig. 2 Concluded

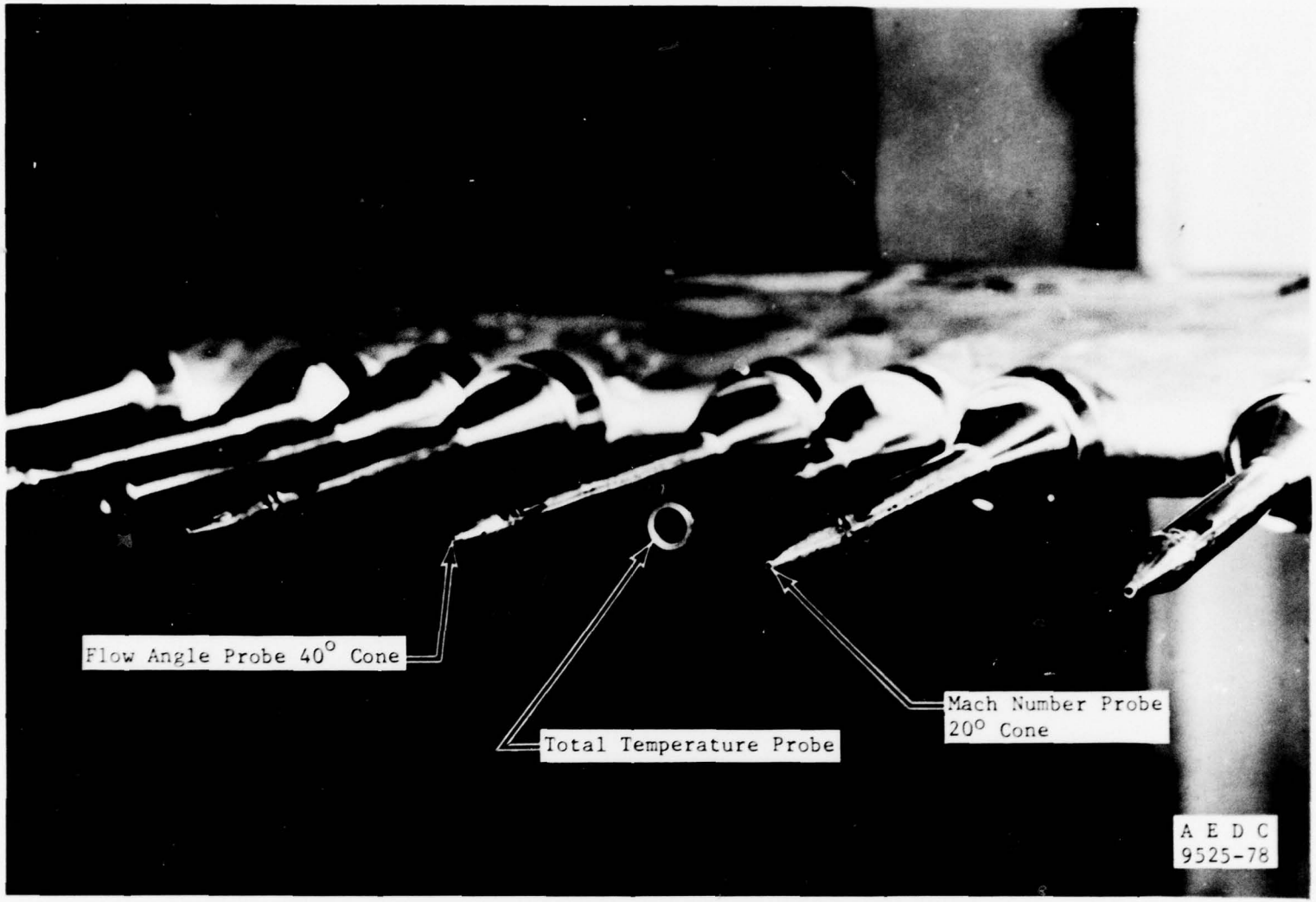


Fig. 3 Photograph Showing Probe Cluster Details

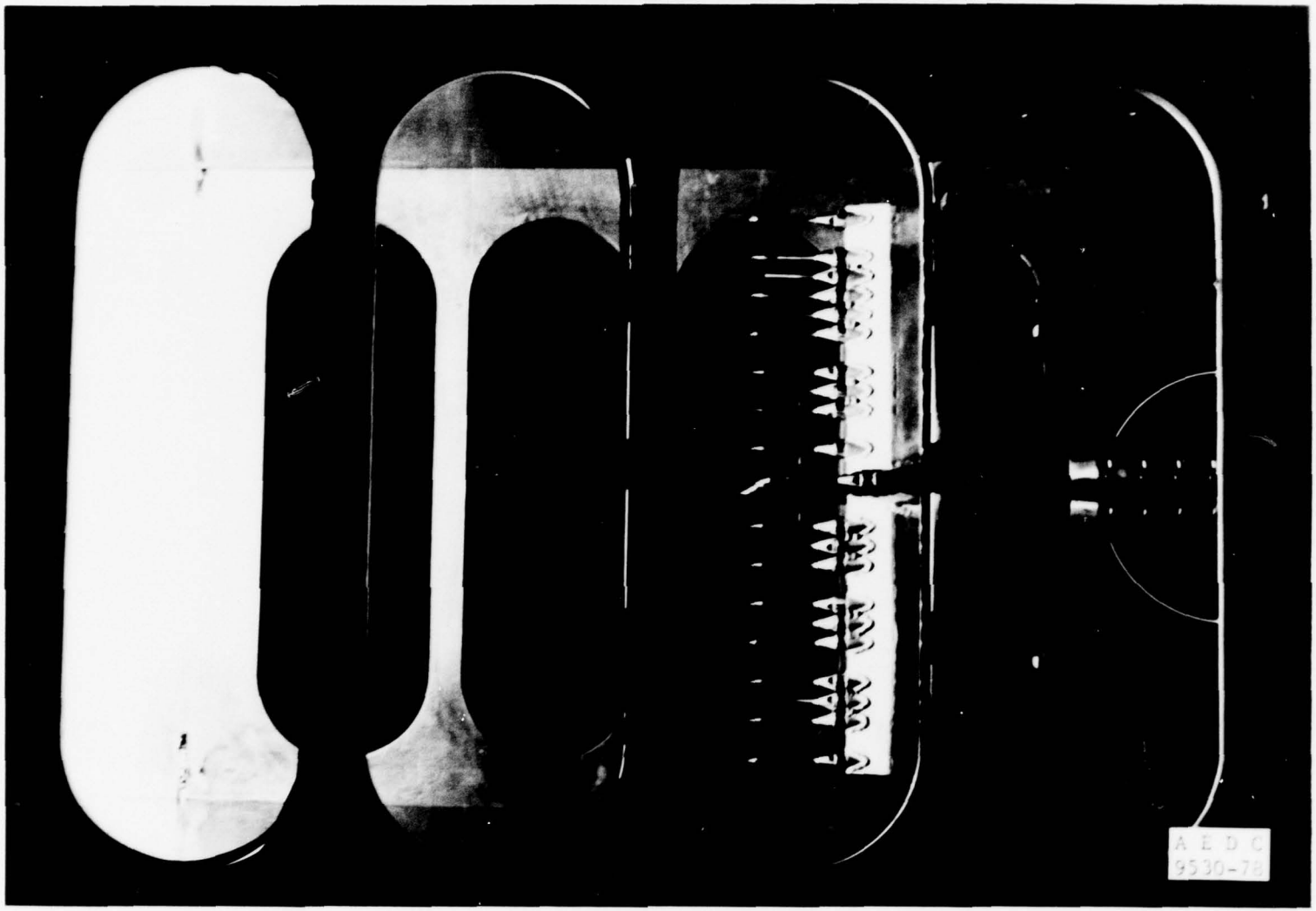


Fig. 4 Photograph Showing APTU Rake Installed in Tunnel A

APPENDIX II

TABLES

VKF TUNNEL A TEST LOG TABLE I

PAGE 1 OF 3

ARO, Inc.

USER: ETF/APTU PROJECTS

PROJECT TITLE: APTU RAKE CALIBRATION

PROJECT: V41A-53

DATE: 24 OCT 1978

REPRESENTATIVE(S):

MODEL:

ARO TEST PERSONNEL: CROSBY/STRIKE

Data Group	Configuration	Config. Confirmed	M_∞	P_0 psia	T_0 °R	α, deg	ϕ, deg	Re/ft $\times 10^6$				Time	Remarks
1	RAKE		5.05	110	640	A	0	5.0					
3			↓	↓	↓	A	-90	↓					
4			↓	↓	↓	0	180	↓					
5			↓	↓	↓	A	0	↓					REPEAT OF GROUP NO. 1
6			4.01	52	580	A	0	↓					
7			↓	↓	↓	A	-90	↓					
8			↓	↓	↓	0	120	↓					
9			3.00	34	560	A	0	↓					
10			↓	↓	↓	↓	+90	↓					
11			↓	↓	↓	↓	180	↓					
12			↓	↓	↓	↓	-90	↓					
13			↓	7	↓	↓	0	1.0					
14			↓	47	↓	↓	0	7.0					
16			2.50	26	↓	↓	0	5.0					
17			↓	↓	↓	↓	-90	↓					
18			↓	↓	↓	0	180	↓					
20			2.00	20	↓	A	0	↓					
21			↓	↓	↓	A	-90	↓					
22			↓	↓	↓	0	180	↓					

NOMENCLATURE

20 A = 0, -6, -4, -2, 0, +2, +4, +6

VB-2 (9/77)

VKF TUNNEL A TEST LOG

TABLE I (CONTINUED)

PAGE 2 OF 3

ARO, INC.

USER: ETF / APTU PROJECTS

REPRESENTATIVES:

PROJECT TITLE: APTU RAKE CALIBRATION

MODEL:

PROJECT: V41A-53

DATE: 25 OCT 1978

ARO TEST PERSONNEL: CROSBY / STRIKE

Data Group	Configuration	Config. Confirmed	M_∞	P_0 psia	T_0 °R	α, deg	ϕ, deg	Re/ft $\times 10^6$				Time	Remarks
24	RAKE		1.76	17	560	A	0	5.0					
25						A	-90						
26						0	180						
27				16		A	+45						
28			4.52	82	590		0						
29							-90						
30							+45						
31			3.51	44	580		0						PMS (PRESSURE MONITORING SYSTEM) OUT
32							-90						
33							+45						PMS OUT

NOMENCLATURE

N A = 0, -6, -4, -2, 0, +2, +4, +6

VB-2 (9/77)

VKF TUNNEL A TEST LOG

TABLE 1 (CONCLUDED)

PAGE 3 OF 3

ARO, Inc.

USER: ETF/ APTU PROJECTS

PROJECT TITLE: APTU RAKE CALIBRATION

PROJECT: V41A-53

DATE OF TEST: 9 NOV 1978

REPRESENTATIVE(S):

MODEL:

ARO TEST PERSONNEL: CROSBY / STRIKE

Data Group	Configuration	Config. Confirmed	M_∞	P_0 psia	T_0 °R	α, deg	ϕ, deg	Re/ft x 10^6				Time	Remarks
34	RAKE		4.52	80	590	A	0	5.0					
35			↓	↓	↓	↓	-90	↓					
36			↓	↓	↓	↓	0	↓					REPEAT OF GROUP NO. 34, PMS (PRESSURE MONITORING SYSTEM) OUT
37			3.51	46	580	↓	0	↓					
38			↓	↓	↓	↓	-90	↓					
39			2.50	26	560	↓	0	↓					
40			↓	↓	↓	↓	-90	↓					
41			2.00	21	↓	↓	0	↓					
42			↓	↓	↓	↓	-90	↓					
43			3.00	31	↓	↓	0	↓					
44			↓	↓	↓	↓	-90	↓					

NOMENCLATURE

NOTES: A = 0, -6, -4, -2, 0, +2, +4, +6

VB-2 (9/77)

APPENDIX III

SAMPLE TABULATED DATA

ARO, INC. - AEDC DIVISION
A SVERDRUP CORPORATION COMPANY
VON KARMAN GAS DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
APTU RAKE CALIBRATION

UNCLASSIFIED

DATE COMPUTED 13-NOV-78
TIME COMPUTED 10:05:15
DATE RECORDED 10-NOV-78
TIME RECORDED 5: 5:56
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
1	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

PITOT PRESSURE PCRT-N(PSIA)

ALPHA (DEG)	11	10	8	6	5	3	2	1	22	24	25	27	28	30	31
0.01	9.741	9.844	9.850	9.745	9.720	9.734	9.755	9.744	9.750	9.693	9.758	9.609	9.642	9.708	9.682
-6.02	9.787	9.877	9.861	9.802	9.786	9.767	9.797	9.779	9.793	9.729	9.789	9.661	9.696	9.751	9.714
-3.99	9.808	9.896	9.912	9.827	9.800	9.792	9.807	9.791	9.795	9.728	9.799	9.674	9.698	9.766	9.725
-1.99	9.796	9.885	9.906	9.809	9.775	9.777	9.794	9.785	9.776	9.720	9.794	9.657	9.689	9.752	9.716
-0.01	9.792	9.871	9.890	9.795	9.764	9.768	9.786	9.782	9.764	9.712	9.786	9.644	9.687	9.747	9.691
2.00	9.784	9.875	9.869	9.777	9.751	9.755	9.774	9.771	9.767	9.726	9.789	9.637	9.713	9.762	9.694
4.01	9.809	9.899	9.897	9.805	9.775	9.769	9.792	9.795	9.769	9.739	9.791	9.664	9.716	9.768	9.719
6.00	9.838	9.922	9.904	9.815	9.806	9.789	9.814	9.798	9.796	9.762	9.803	9.681	9.706	9.774	9.736

PITOT PRESSURE PCRT-N(PSIA)

ALPHA (DEG)	21	20	18	17	15	14	12	1	32	34	35	37	38	40	41
0.01	9.878	9.773	9.843	9.842	9.749	9.640	9.751	9.744	9.747	9.882	9.787	9.776	9.785	9.707	9.656
-6.02	9.832	9.788	9.782	9.825	9.771	9.297	9.749	9.779	9.719	9.871	9.803	9.742	9.827	9.731	9.573
-3.99	9.885	9.812	9.833	9.852	9.784	9.447	9.763	9.791	9.767	9.879	9.818	9.773	9.840	9.727	9.614
-1.99	9.896	9.791	9.838	9.839	9.765	9.545	9.752	9.785	9.774	9.875	9.784	9.786	9.811	9.705	9.637
-0.01	9.878	9.784	9.845	9.840	9.744	9.630	9.748	9.782	9.786	9.883	9.770	9.763	9.800	9.704	9.663
2.00	9.851	9.792	9.850	9.830	9.762	9.710	9.768	9.771	9.789	9.895	9.759	9.765	9.802	9.723	9.680
4.01	9.857	9.803	9.865	9.837	9.775	9.759	9.762	9.795	9.776	9.904	9.760	9.784	9.811	9.731	9.732
6.00	9.860	9.821	9.870	9.826	9.790	9.783	9.744	9.798	9.762	9.913	9.775	9.785	9.826	9.765	9.761

ARO, INC. - AEDC DIVISION
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VON KARMAN GAS DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
APTU RAKE CALIBRATION

UNCLASSIFIED

DATE COMPUTED 13-NOV-78
TIME COMPUTED 10:05:16
DATE RECORDED 10-NOV-78
TIME RECORDED 5: 5:56
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
2	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

PITOT PRESSURE RATIO PCRT-N/POP

ALPHA (DEG)	11	10	8	6	5	3	2	1	22	24	25	27	28	30	31
0.01	0.994	1.004	1.005	0.994	0.992	0.993	0.995	0.994	0.995	0.989	0.996	0.980	0.984	0.990	0.988
-6.02	0.999	1.008	1.007	1.001	0.999	0.997	1.000	0.998	1.000	0.993	0.999	0.986	0.990	0.995	0.992
-3.99	1.000	1.009	1.010	1.002	0.999	0.998	1.000	0.998	0.998	0.992	0.999	0.986	0.989	0.995	0.991
-1.99	0.997	1.006	1.009	0.999	0.995	0.995	0.997	0.996	0.995	0.990	0.997	0.983	0.986	0.993	0.989
-0.01	1.000	1.008	1.010	1.000	0.997	0.998	1.000	0.999	0.997	0.992	1.000	0.985	0.989	0.996	0.990
2.00	0.998	1.007	1.007	0.998	0.995	0.995	0.997	0.997	0.996	0.992	0.999	0.983	0.991	0.996	0.989
4.01	1.001	1.010	1.010	1.000	0.997	0.997	0.999	0.999	0.996	0.993	0.999	0.986	0.991	0.996	0.991
6.00	1.004	1.012	1.010	1.001	1.000	0.999	1.001	1.000	0.999	0.996	1.000	0.988	0.990	0.997	0.993

PITOT PRESSURE RATIO PCRT-N/POP

ALPHA (DEG)	21	20	18	17.	15	14	12	1	32	34	35	37	38	40	41
0.01	1.008	0.997	1.004	1.004	0.995	0.983	0.995	0.994	0.994	1.008	0.998	0.997	0.998	0.990	0.985
-6.02	1.004	0.999	0.998	1.003	0.997	0.949	0.995	0.998	0.992	1.008	1.001	0.994	1.003	0.993	0.977
-3.99	1.008	1.000	1.002	1.004	0.997	0.963	0.995	0.998	0.996	1.007	1.001	0.996	1.003	0.991	0.980
-1.99	1.008	0.997	1.002	1.002	0.994	0.972	0.993	0.996	0.995	1.005	0.996	0.996	0.999	0.988	0.981
-0.01	1.009	0.999	1.006	1.005	0.995	0.984	0.996	0.999	1.000	1.009	0.998	0.997	1.001	0.991	0.987
2.00	1.005	0.999	1.005	1.003	0.996	0.991	0.996	0.997	0.999	1.009	0.996	0.996	1.000	0.992	0.988
4.01	1.006	1.000	1.006	1.003	0.997	0.995	0.996	0.999	0.997	1.010	0.996	0.998	1.001	0.993	0.993
6.00	1.006	1.002	1.007	1.002	0.999	0.998	0.994	1.000	0.996	1.011	0.997	0.998	1.002	0.996	0.996

ARO, INC. - AEDC DIVISION
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APTU RAKE CALIBRATION

UNCLASSIFIED

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TIME COMPUTED 10:05:16
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TIME RECORDED 5: 5:56
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PT0(PSIA)	TT0(DEG. R)	RHO0(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
3	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

MACH NO. DETERMINED FROM ADIABATIC RELATIONS MNS-N

ALPHA (DEG)	11	10	8	6	5	3	2	1	22	24	25	27	28	30	31
0.01	3.517	3.505	3.504	3.517	3.520	3.518	3.516	3.517	3.516	3.523	3.515	3.533	3.529	3.521	3.524
-6.02	3.511	3.501	3.502	3.509	3.511	3.513	3.510	3.512	3.511	3.518	3.511	3.526	3.522	3.515	3.520
-3.99	3.510	3.500	3.498	3.508	3.511	3.512	3.510	3.512	3.512	3.520	3.511	3.526	3.523	3.515	3.520
-1.99	3.513	3.503	3.500	3.512	3.516	3.515	3.513	3.514	3.515	3.522	3.513	3.530	3.526	3.518	3.523
-0.01	3.510	3.501	3.498	3.509	3.518	3.513	3.511	3.511	3.513	3.519	3.511	3.527	3.522	3.515	3.522
2.00	3.512	3.501	3.502	3.513	3.516	3.516	3.513	3.514	3.514	3.519	3.512	3.530	3.521	3.515	3.523
4.01	3.509	3.499	3.499	3.510	3.513	3.514	3.511	3.511	3.514	3.518	3.511	3.527	3.520	3.514	3.520
6.00	3.506	3.496	3.498	3.509	3.510	3.512	3.509	3.511	3.511	3.515	3.510	3.524	3.522	3.513	3.518

MACH NO. DETERMINED FROM ADIABATIC RELATIONS MNS-N

ALPHA (DEG)	21	20	18	17	15	14	12	1	32	34	35	37	38	40	41
0.01	3.501	3.513	3.505	3.505	3.516	3.529	3.516	3.517	3.516	3.501	3.512	3.513	3.512	3.521	3.527
-6.02	3.506	3.511	3.512	3.507	3.513	3.571	3.516	3.512	3.519	3.501	3.509	3.517	3.506	3.518	3.537
-3.99	3.501	3.510	3.507	3.505	3.513	3.554	3.516	3.512	3.515	3.502	3.509	3.514	3.507	3.520	3.533
-1.99	3.501	3.514	3.508	3.508	3.517	3.543	3.518	3.514	3.516	3.504	3.514	3.514	3.511	3.524	3.532
-0.01	3.500	3.511	3.504	3.504	3.515	3.529	3.515	3.511	3.511	3.499	3.512	3.513	3.509	3.520	3.525
2.00	3.504	3.511	3.504	3.507	3.515	3.521	3.514	3.514	3.511	3.499	3.515	3.514	3.510	3.519	3.524
4.01	3.504	3.510	3.503	3.506	3.513	3.515	3.515	3.511	3.513	3.498	3.515	3.512	3.509	3.519	3.518
6.00	3.503	3.508	3.502	3.507	3.512	3.512	3.517	3.511	3.515	3.497	3.513	3.512	3.507	3.514	3.515

ARO, INC. - AEDC DIVISION
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UNCLASSIFIED

DATE COMPUTED 13-NOV-78
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TIME RECORDED 5: 5:56
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
4	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

STATIC PRESSURE PCRS-N(PSIA) 20-DEGREE CONE PROBE

ALPHA (DEG)	10	8	5	3	2	22	24	25	28	30
0.01	0.996	0.995	0.990	0.984	0.972	0.984	0.987	0.963	0.987	0.980
-6.02	0.963	0.948	0.985	0.999	0.966	0.962	0.905	0.977	0.929	0.940
-3.99	0.997	0.954	0.955	0.978	0.963	0.963	0.917	0.974	0.962	0.940
-1.99	1.004	0.986	0.975	0.981	0.972	0.977	0.959	0.971	0.989	0.968
-0.01	0.999	1.000	0.996	0.986	0.975	0.987	0.990	0.967	0.992	0.983
2.00	0.990	0.996	0.996	0.983	0.961	0.980	0.993	0.956	0.968	0.979
4.01	0.964	0.974	0.970	0.956	0.934	0.955	0.962	0.929	0.926	0.949
6.00	0.945	0.954	0.939	0.917	0.934	0.927	0.924	0.897	0.957	0.918

STATIC PRESSURE PCRS-N(PSIA) 20-DEGREE CONE PROBE

ALPHA (DEG)	20	18	15	14	12	32	34	35	38	40
0.01	0.987	0.990	0.990	0.973	0.974	0.991	1.013	1.036	0.997	0.845
-6.02	0.908	0.976	0.909	0.956	0.884	0.941	0.935	1.141	0.964	0.872
-3.99	0.950	0.958	0.941	0.945	0.927	0.956	0.968	1.104	0.942	0.842
-1.99	0.983	0.971	0.977	0.954	0.962	0.981	1.004	1.068	0.978	0.838
-0.01	0.988	0.989	0.988	0.972	0.972	0.996	1.013	1.032	0.999	0.844
2.00	0.962	0.996	0.976	0.973	0.956	0.994	0.994	0.990	0.996	0.882
4.01	0.927	0.976	0.939	0.967	0.927	0.943	0.960	0.936	0.966	0.965
6.00	0.939	0.947	0.915	0.934	0.920	0.912	0.944	0.875	0.923	0.979

ARO, INC. - AEDC DIVISION
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UNCLASSIFIED

DATE COMPUTED 13-NOV-78
TIME COMPUTED 10:05:17
DATE RECORDED 10-NOV-78
TIME RECORDED 51 5156
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.91	46.43	976.67	6.794E-03	9.012E+00

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
5	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

STATIC PRESSURE RATIO PCRS-N/PCRT-N 20-DEG CONE PROBE

ALPHA (DEG)	10	8	5	3	2	22	24	25	28	30
0.01	0.10113	0.10099	0.10181	0.10104	0.09960	0.10091	0.10188	0.09866	0.10238	0.10100
-6.02	0.09751	0.09614	0.10066	0.10232	0.09857	0.09825	0.09299	0.09982	0.09581	0.09642
-3.99	0.10073	0.09625	0.09747	0.09985	0.09821	0.09834	0.09427	0.09937	0.09916	0.09628
-1.99	0.10161	0.09957	0.09974	0.10038	0.09920	0.09992	0.09863	0.09917	0.10211	0.09930
-0.01	0.10116	0.10110	0.10197	0.10098	0.09962	0.10107	0.10194	0.09886	0.10243	0.10089
2.00	0.10022	0.10092	0.10210	0.10074	0.09832	0.10034	0.10209	0.09767	0.09965	0.10027
4.01	0.09742	0.09839	0.09922	0.09790	0.09539	0.09771	0.09883	0.09485	0.09535	0.09711
6.00	0.09528	0.09637	0.09577	0.09369	0.09513	0.09466	0.09464	0.09152	0.09860	0.09388

STATIC PRESSURE RATIO PCRS-N/PCRT-N 20-DEG CONE PROBE

ALPHA (DEG)	20	18	15	14	12	32	34	35	38	40
0.01	0.10101	0.10062	0.10152	0.10097	0.09992	0.10171	0.10249	0.10589	0.10192	0.08705
-6.02	0.09281	0.09977	0.09299	0.10279	0.09068	0.09678	0.09469	0.11642	0.09810	0.08965
-3.99	0.09677	0.09744	0.09619	0.10004	0.09500	0.09785	0.09798	0.11243	0.09574	0.08656
-1.99	0.10044	0.09873	0.10001	0.09990	0.09868	0.10036	0.10167	0.10918	0.09972	0.08632
-0.01	0.10103	0.10043	0.10135	0.10090	0.09973	0.10174	0.10248	0.10564	0.10198	0.08694
2.00	0.09821	0.10116	0.09995	0.10024	0.09783	0.10050	0.10049	0.10146	0.10165	0.09067
4.01	0.09459	0.09894	0.09607	0.09904	0.09500	0.09647	0.09692	0.09594	0.09843	0.09 15
6.00	0.09565	0.09591	0.09346	0.09549	0.09439	0.09342	0.09523	0.08948	0.09395	0.10022

ARO, INC. - AEDC DIVISION
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GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
6	2220.11	0.600	166.5	3.024E-06	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XI(INCHES)
9.8019	5.1758	1.3396E-07	6.60

STATIC PRESSURE PCRS1-N(PSIA) 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	1.815	2.013	2.082	1.765	1.920	1.906	1.906	1.832	1.964
-6.02	1.789	1.998	2.032	1.709	1.846	1.879	1.881	1.785	1.908
-3.99	1.798	2.009	2.056	1.727	1.876	1.885	1.901	1.804	1.934
-1.99	1.814	2.022	2.072	1.757	1.901	1.901	1.904	1.819	1.949
-0.01	1.823	2.023	2.086	1.771	1.923	1.906	1.904	1.830	1.960
2.00	1.827	2.022	2.094	1.782	1.937	1.908	1.899	1.830	1.973
4.01	1.831	2.021	2.106	1.796	1.939	1.903	1.887	1.828	1.978
6.00	1.830	2.011	2.103	1.805	1.936	1.896	1.876	1.815	1.979

STATIC PRESSURE PCRS3-N(PSIA) 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	2.023	1.789	1.665	2.074	1.911	1.961	1.992	2.085	1.740
-6.02	2.016	1.795	1.680	2.084	1.929	1.950	1.942	2.033	1.723
-3.99	2.030	1.800	1.672	2.091	1.924	1.973	1.968	2.058	1.734
-1.99	2.035	1.801	1.675	2.091	1.921	1.968	1.984	2.075	1.738
-0.01	2.035	1.798	1.670	2.089	1.916	1.964	1.992	2.085	1.739
2.00	2.035	1.794	1.664	2.089	1.903	1.953	1.995	2.085	1.740
4.01	2.036	1.784	1.658	2.085	1.888	1.938	1.995	2.088	1.736
6.00	2.032	1.773	1.648	2.078	1.878	1.918	1.983	2.085	1.730

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UNCLASSIFIED

DATE COMPUTED 13-NOV-78
TIME COMPUTED 10:05:18
DATE RECORDED 10-NOV-78
TIME RECORDED 5: 5:56
PROJECT NUMBER V41A-53A

GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
7	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

STATIC PRESSURE PCRS2-N(PSIA) 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	2.024	1.807	1.943	1.800	1.878	1.774	2.057	1.925	0.000
-6.02	1.411	1.270	1.363	1.270.	1.315	1.257	1.414	1.330	0.000
-3.99	1.584	1.415	1.506	1.415	1.468	1.397	1.591	1.492	0.000
-1.99	1.787	1.585	1.702	1.588	1.650	1.561	1.797	1.683	0.000
-0.01	2.031	1.801	1.942	1.802	1.876	1.768	2.045	1.917	0.000
2.00	2.298	2.052	2.224	2.048	2.129	2.017	2.316	2.185	0.000
4.01	2.590	2.338	2.531	2.325	2.408	2.318	2.610	2.482	0.000
6.00	2.899	2.644	2.856	2.625	2.704	2.619	2.913	2.795	0.000

STATIC PRESSURE PCRS4-N(PSIA) 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	1.792	1.975	1.775	2.024	1.993	2.087	1.843	1.958	2.164
-6.02	2.639	2.880	2.656	2.933	2.859	2.990	2.701	2.819	3.072
-3.99	2.329	2.572	2.334	2.618	2.551	2.679	2.397	2.517	2.764
-1.99	2.058	2.285	2.046	2.327	2.268	2.388	2.117	2.235	2.466
-0.01	1.805	1.996	1.786	2.047	2.002	2.098	1.851	1.962	2.171
2.00	1.595	1.746	1.571	1.792	1.762	1.831	1.627	1.720	1.903
4.01	1.424	1.545	1.406	1.578	1.559	1.606	1.444	1.518	1.672
6.00	1.281	1.375	1.362	1.404	1.391	1.422	1.293	1.351	1.478

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GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
8	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

STATIC PRESSURE DIFFERENTIAL RATIO DPP-N/PCRT-N 40-DEGREE CONE PROBE (PITCH PLANE)

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	-2.376E-02	1.717E-02	-1.725E-02	2.329E-02	1.186E-02	3.169E-02	-2.1[illegible]3E-02	3.395E-03	0.000E+00
-6.02	1.254E-01	1.643E-01	1.323E-01	1.722E-01	1.589E-01	1.762E-01	1.310E-01	1.529E-01	0.000E+00
-3.99	7.596E-02	1.177E-01	8.456E-02	1.243E-01	1.113E-01	1.297E-01	8.186E-02	1.049E-01	0.000E+00
-1.99	2.762E-02	7.141E-02	3.518E-02	7.654E-02	6.358E-02	8.353E-02	3.251E-02	5.643E-02	0.000E+00
-0.01	-2.312E-02	1.993E-02	-1.593E-02	2.539E-02	1.298E-02	3.347E-02	-1.977E-02	4.608E-03	0.000E+00
2.00	-7.183E-02	-3.127E-02	-6.679E-02	-2.648E-02	-3.779E-02	-1.888E-02	-7.008E-02	-4.765E-02	0.000E+00
4.01	-1.189E-01	-8.086E-02	-1.148E-01	-7.735E-02	-8.731E-02	-7.222E-02	-1.184E-01	-9.852E-02	0.000E+00
6.00	-1.645E-01	-1.293E-01	-1.525E-01	-1.261E-01	-1.349E-01	-1.214E-01	-1.64[illegible]E-01	-1.475E-01	0.000E+00

STATIC PRESSUPE DIFFERENTIAL RATIO DPY-N/PCRT-N 40-DEGREE CONE PROBE (YAW PLANE)

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	2.137E-02	-2.295E-02	-4.282E-02	3.218E-02	-9.224E-04	5.613E-03	8.727E-03	2.580E-02	-2.320E-02
-6.02	2.317E-02	-1.960E-02	-3.609E-02	3.883E-02	8.555E-03	7.183E-03	6.164E-03	2.548E-02	-1.938E-02
-3.99	2.368E-02	-2.130E-02	-3.914E-02	3.765E-02	4.943E-03	8.848E-03	6.809E-03	2.593E-02	-2.080E-02
-1.99	2.254E-02	-2.254E-02	-4.059E-02	3.459E-02	2.037E-03	6.795E-03	8.178E-03	2.611E-02	-2.185E-02
-0.01	2.165E-02	-2.300E-02	-4.253E-02	3.302E-02	-6.586E-04	5.911E-03	8.987E-03	2.605E-02	-2.288E-02
2.00	2.128E-02	-2.339E-02	-4.400E-02	3.183E-02	-3.536E-03	4.559E-03	9.766E-03	2.613E-02	-2.410E-02
4.01	2.083E-02	-2.414E-02	-4.573E-02	2.996E-02	-5.224E-03	3.498E-03	1.101E-02	2.651E-02	-2.492E-02
6.00	2.047E-02	-2.420E-02	-4.649E-02	2.826E-02	-5.955E-03	2.249E-03	1.086E-02	2.767E-02	-2.549E-02

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GROUP	MACH(INF)	PTO(PSIA)	TTO(DEG. R)	RHOO(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
9	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

AVERAGE STATIC PRESSURE PCRSA-N(PSIA) 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	1.913	1.896	1.866	1.916	1.926	1.932	1.950	1.950	1.956
-6.02	1.954	1.983	1.933	1.999	1.987	2.019	1.984	1.992	2.234
-3.99	1.935	1.949	1.892	1.963	1.955	1.984	1.964	1.968	2.144
-1.99	1.924	1.923	1.874	1.940	1.935	1.954	1.951	1.953	2.051
-0.01	1.924	1.904	1.871	1.927	1.929	1.934	1.948	1.949	1.957
2.00	1.939	1.904	1.888	1.928	1.933	1.927	1.959	1.955	1.872
4.01	1.970	1.922	1.925	1.946	1.949	1.941	1.984	1.979	1.795
6.00	2.010	1.951	1.992	1.978	1.977	1.964	2.016	2.012	1.729

AVERAGE STATIC PRESSURE RATIO PCRSA-N/PCRT-N 40-DEGREE CONE PROBE

ALPHA (DEG)	11	6	1	27	31	21	17	37	41
0.01	0.196	0.195	0.192	0.199	0.199	0.196	0.198	0.199	0.203
-6.02	0.201	0.202	0.198	0.207	0.205	0.205	0.202	0.204	0.233
-3.99	0.197	0.198	0.193	0.203	0.201	0.201	0.199	0.201	0.223
-1.99	0.196	0.196	0.191	0.201	0.199	0.197	0.198	0.200	0.213
-0.01	0.196	0.194	0.191	0.200	0.199	0.196	0.198	0.200	0.203
2.00	0.198	0.195	0.193	0.200	0.199	0.196	0.199	0.200	0.193
4.01	0.201	0.196	0.197	0.201	0.200	0.197	0.202	0.202	0.184
6.00	0.204	0.199	0.203	0.204	0.203	0.199	0.205	0.206	0.177

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GROUP	MACH(INF)	PT0(PSIA)	TT0(DEG. R)	RHO0(SLUGS/FT3)	RE/FT
38	3.51	46.43	576.67	6.754E-03	5.012E+06

PAGE	U(FT/SEC)	PINF(PSIA)	TINF(DEG. R)	RHOINF(SLUGS/FT3)	PHI(DEG)
10	2220.11	0.600	166.5	3.024E-04	-89.94

POP(PSIA)	QINF(PSIA)	MUINF(LBF-SEC/FT2)	XT(INCHES)
9.8019	5.1758	1.3396E-07	6.60

TUNNEL CONDITIONS

ALPHA (DEG)	PT0 (PSIA)	TT0 (R)	PINF (PSIA)	TINF (R)	QINF (PSIA)	POP (PSIA)	TIME
0.01	46.43	576.7	0.600	166.5	5.176	9.80	5- 5-56
-6.02	46.41	576.7	0.600	166.5	5.173	9.80	5- 7-40
-3.99	46.47	577.7	0.601	166.8	5.180	9.81	5- 8-57
-1.99	46.53	577.7	0.601	166.8	5.186	9.82	5-10-24
-0.01	46.38	576.7	0.599	166.5	5.170	9.79	5-11-35
2.00	46.43	576.7	0.600	166.5	5.176	9.80	5-12-47
4.01	46.44	577.7	0.600	166.8	5.176	9.80	5-14-11
6.00	46.44	577.7	0.600	166.8	5.176	9.80	5-15-40

AVERAGE PRESSURES

ALPHA (DEG)	PCPTAV (PSIA)	PCPSAV (PSIA)	PCPS1AV (PSIA)	PCPS2AV (PSIA)	PCPS3AV (PSIA)	PCPS4AV (PSIA)
0.01	9.7514	0.9817	1.9114	1.9011	1.9155	1.9568
-6.02	9.7552	0.9530	1.8686	1.3287	1.9057	2.8387
-3.99	9.7797	0.9568	1.8877	1.4836	1.9166	2.5288
-1.99	9.7734	0.9750	1.9043	1.6691	1.9209	2.2433
-0.01	9.7695	0.9834	1.9140	1.8979	1.9210	1.9686
2.00	9.7731	0.9755	1.9192	2.1585	1.9175	1.7276
4.01	9.7884	0.9513	1.9211	2.4501	1.9120	1.5280
6.00	9.8009	0.9300	1.9167	2.7570	1.9028	1.3731